HYNETWORK
SERVICES

Repurposing natural gas pipelines and the effect on H2 quality

7 November 2022

Peter van Wesenbeeck

Hydrogen specification
Introduction

Requirements

- Provides support for various hydrogen production processes (blue, green, etc)
- Does not require pre-treatment for the majority of end users
- Facilitates reuse of natural gas pipeline infrastructure
- Guarantees the interchangeability of hydrogen within Europe

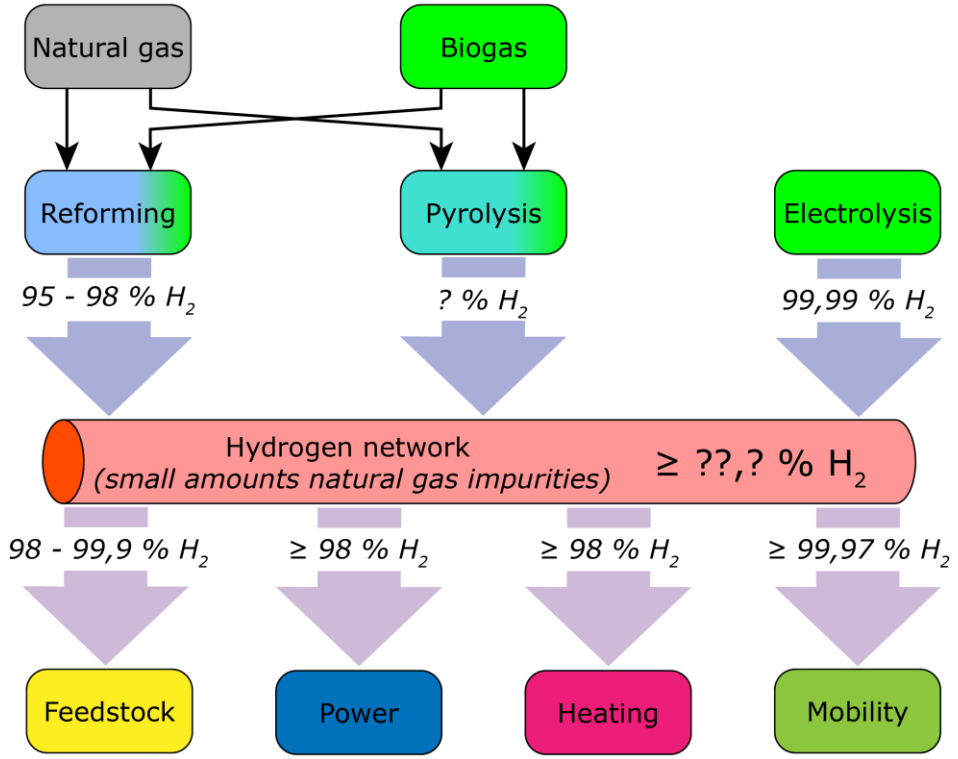
Contains

- Minimum hydrogen content
- Limit values for critical (trace)components and physico-chemical properties

Remarks

- Focus seems to be primarily on the minimum hydrogen content but
- Sensitive end user applications are often only negatively impacted by small amounts of specific traces like oxygen, sulphur

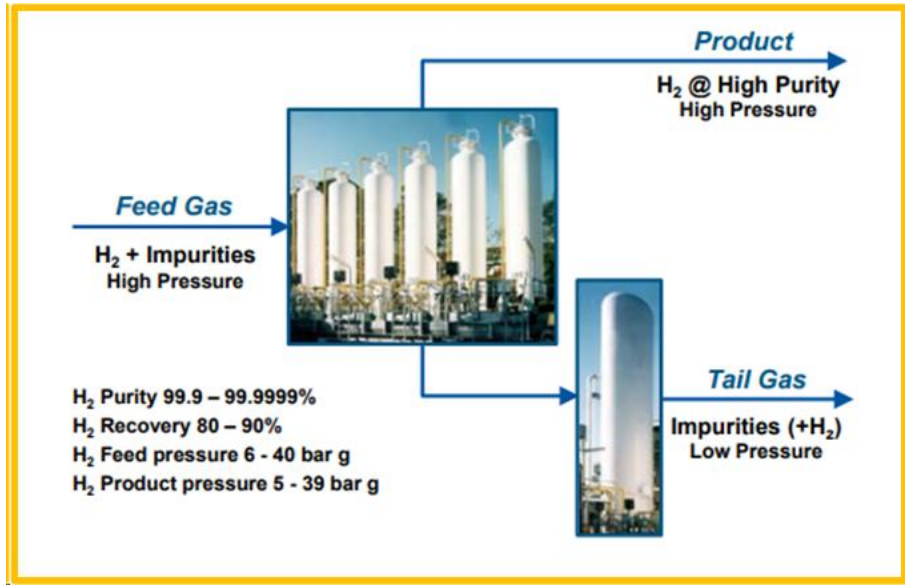
Hydrogen specification
Challenges to be solved



Development of a cost model

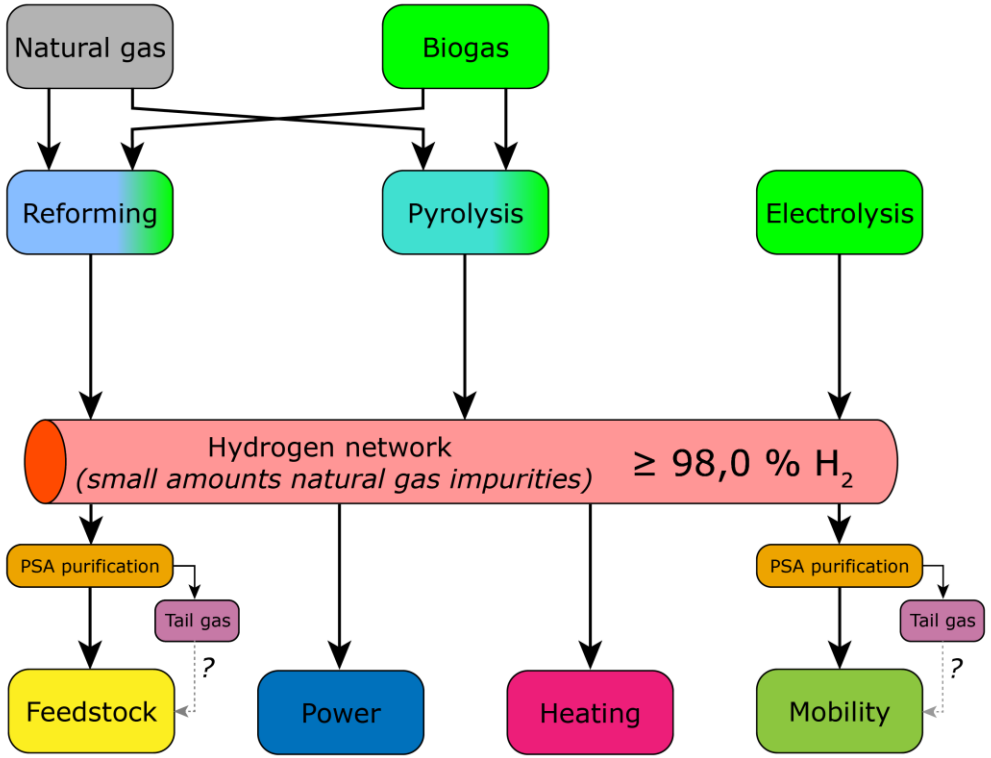
Based on PSA purification technique

- Widely used in hydrogen production and scalable
- If H_2 quality exit > H_2 quality entry a PSA is need
- Green fields (installation on ”new” location)
- Taken into account Capex as well as Opex
  - Tail gas valorisation is an important issue



Hydrogen specification

Lay-out of a low purity hydrogen network



At entry

"Basic" purification as integral part of the production facility

At exit

Purification needed for

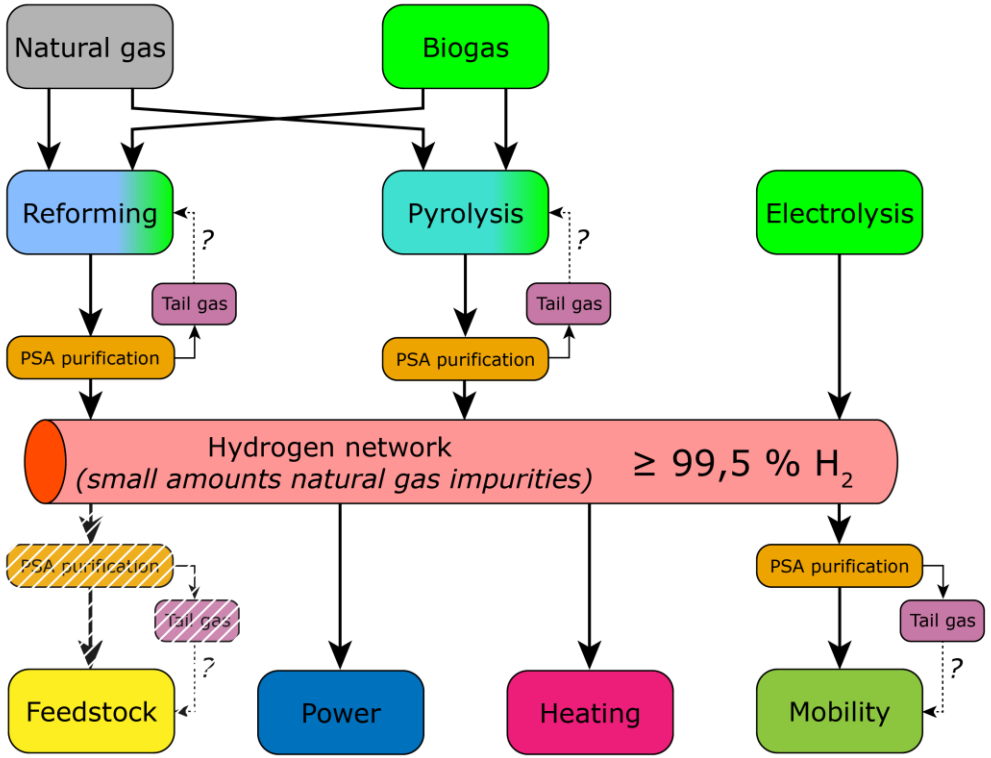
- Some sensitive feedstock processes
- Fuel cell applications

Remark

Small amounts of natural gas impurities from the pipeline taken up by the hydrogen are removed at the exits with sensitive end user applications

Hydrogen specification

Lay-out of a high purity hydrogen network



At entry

Purifying to a high grade hydrogen

At exit

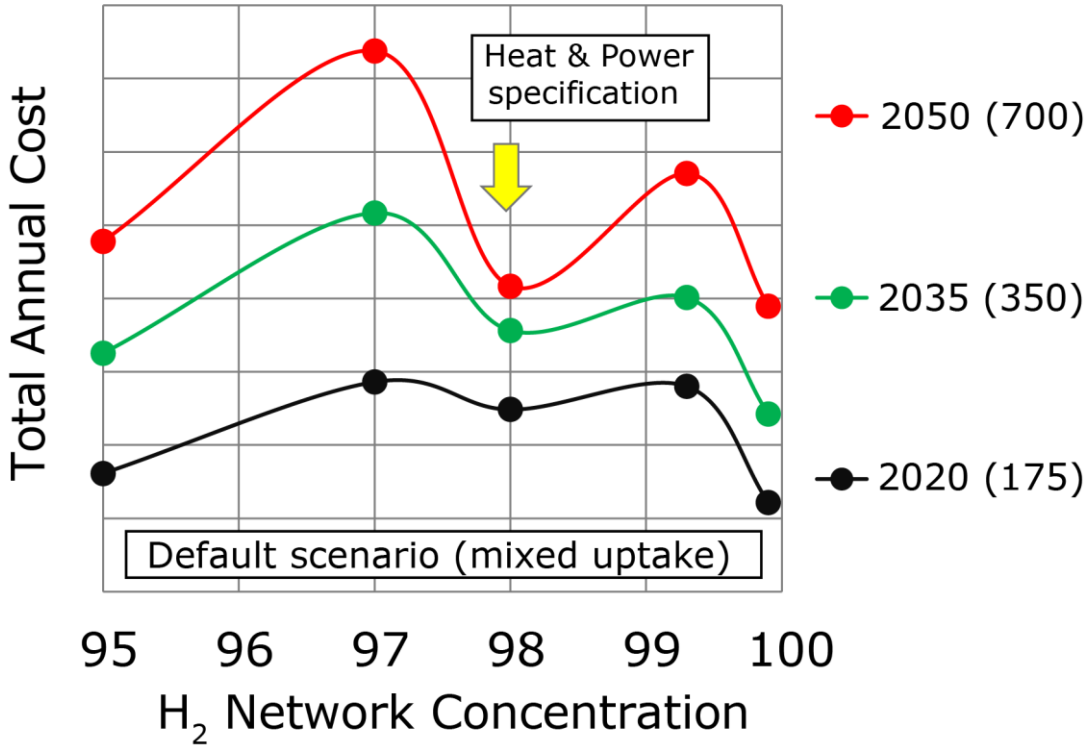
Purification needed for

- Very high purity feedstock processes
- Fuel cell applications

Remark

At the moment not clear to which extend natural gas impurities are taken up from the pipeline by the hydrogen transported

Hydrogen specification
DNV/GU cost model



Legend: year (total market volume - kton/yr)

Pipeline not taken into account

Effect of natural gas residues yet not fully known

Scenario

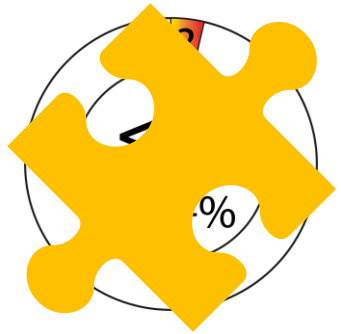
In 2035-2050 scenario's a local cost minimum occurs around the 98% H_2 region due to assumed H_2 rise in power and heat applications (≥ 98% H_2)

Remark

Cost model based on minimum hydrogen content (PSA purification) but removal of specific trace components is also possible with other cheaper purification techniques

HYNETWORK
SERVICES

(Inter)national developments



- In line with (international) hydrogen specifications
  - ISO 14687:2019 – H_2 fuel quality - Product specification
  - UK PAS 4444:2020 – H_2-fired gas appliances guide
  - DE DVGW G260:2021 – Gasbeschaffenheit
  - EU EASEE-gas CBP:2021 – Hydrogen Quality Specification
  - NL Kwaliteitseisen voor waterstof t.b.v. het transportnet (preliminary)
  - BE Fluxys – H_2/CO_2 Quality Specification
  - CEN – Draft Technical Specification (under development)

Draft Technical specification

CEN TC 234/WG11: Hydrogen used in rededicated gas systems

Origin	Component / Physico-chemical Property	Value
H_2 Generation	Hydrogen	≥ 98 mol-%
	Sum of Inerts (e.g. N_2, He, Ar)	≤ 2,0 mol-%
	Carbon Monoxide (CO)	≤ 20 µmol/mol
	Carbon Dioxide (CO_2)	≤ 20 µmol/mol
	Ammonia	≤ 13 µmol/mol
	Halogenated compounds	≤ 0,05 µmol/mol
Ubiquitary	Water	≤ 249 µmol/mol @ MOP ≤ 10 bar
		≤ 62 µmol/mol @ MOP > 10 bar
	Oxygen	≤ 1 mol-%
		≤ 0,001 mol-% if attached to UGS
NG Infra	Hydrocarbon dew point (HCDP)	≤ -2 °C @ 1 ≤ p ≤ 70 bar
	Gaseous Hydrocarbons	≤ 2,0 mol-%
	Total sulfur (*non-odorised hydrogen)*	≤ 7 µmol/mol
	Particulate concentration	Technical free
	Wobbe-Index (*min: 2% N_2, max: 100% H_2*)	40,09 – 45,88 MJ/m³ (15,15)
	Upper heating value (*min 2% N_2, max: 2% CH_4*)	11,86 – 12,10 MJ/m³ (15,15)

Hydrogen shall not contain solid, liquid or gaseous material that might interfere with the integrity or operation of pipes or any gas appliance

Summary

Minimum hydrogen content of 98 %

- Most reasonable approach given large uncertainties in hydrogen production and demand and lack of practical knowledge

Repurposed natural gas pipelines

- Do not limit the minimum hydrogen content to a maximum of 98 %
- Effect of natural gas residues depends on the history / treatment / cleaning of pipe
  - More research is needed to determine the exact effect on the hydrogen quality
  - At the moment very high purity hydrogen (≥ 99,97 % H_2) can not be guaranteed
  - (Effect of) residues diminish(es) with time (transition phase)

Future

- Hydrogen specification is expected to be reviewed frequently